

APPENDIX D: SAFE TORQUE OFF

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INTRODUCTION

INTRODUCTION

The Safe Torque Off (STO) function turns off the power supplied to the motor through the hardware, so that the motor cannot produce torque. This method of removing power from the motor is considered an emergency power off, also known as “coast to stop.” The Safe Torque Off function utilizes two independent hardware circuits to control the motor current drive signal, and thus turns off the inverter power module output in order to achieve the status of safe stop. In normal E-stop situations, both circuits will be opened (using a dual-channel safety relay, etc.).

ACN Series drives have built-in safety functions suitable for modern safety standards. The Safety input function meets EN ISO 13849-1 PLd and EN 61508 SIL2 (EN60204-1, stop category 0).

This feature is standard and enables compliance with current safety standards.

TERMINAL CONFIGURATION

Terminal		Size		Specification
Name	Description	mm ²	AWG	
SC	Safety Input Power	0.25~0.75 mm ² (20~26AWG) Shield Type Twisted pair cable		DC 24V, Below 25mA
SA	Safety Input A			Short: Normal (SC-SA or SB) Open: Safety trip (SC-SA or SB)
SB	Safety Input B			
CM	Common			When using external 24V DC power source for Safe Torque off, connect the ground (0 VDC) of the external 24V DC power source to the CM terminal

SAFE TORQUE OFF TERMINAL FUNCTION DESCRIPTION

OPERATION CONDITIONS DESCRIPTION

To detect a safety situation, 24V power is not detected or external switch (Safety relay) is disconnected to signal both circuits. These two circuits are connected to the CPU, Gate Drive circuit, and serve to block the PWM Gate to shut off the drive output in a safety situation.

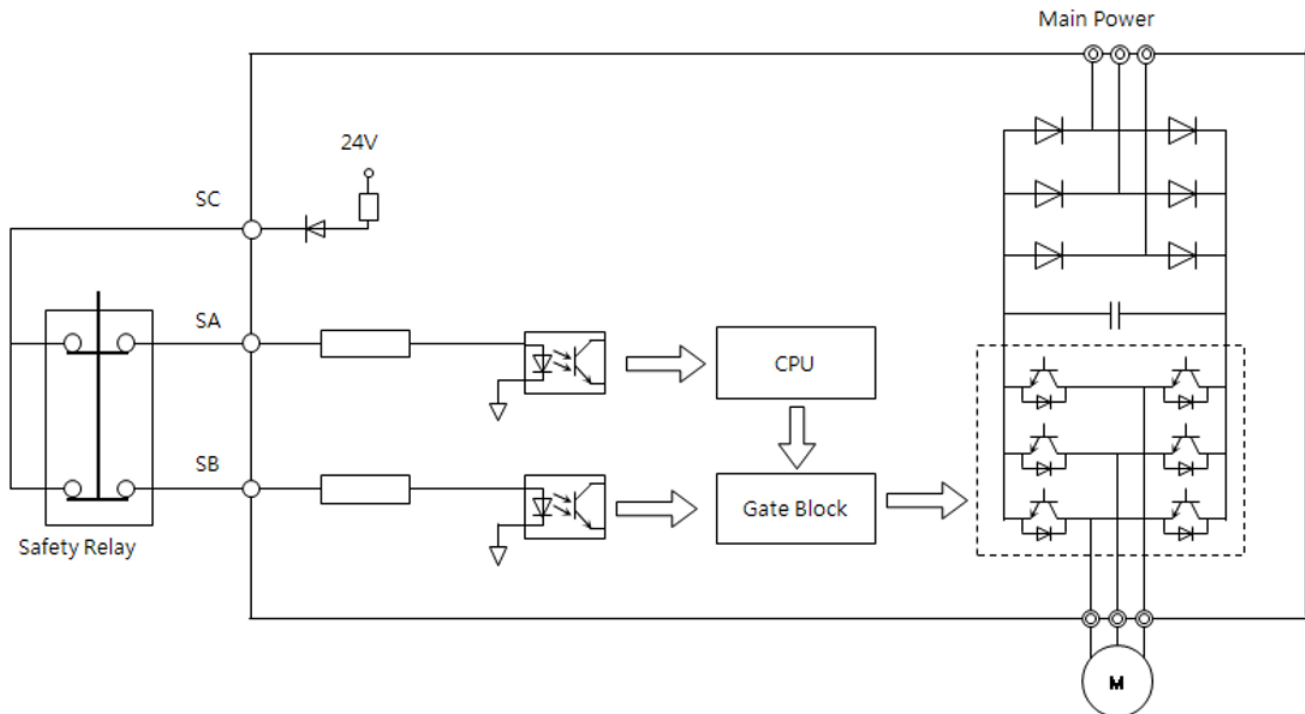
- *IGBT Drive IC Power Off: In a Safety situation, signals are transmitted to the CPU via the Safety A (SA) circuit, turning off the Gate Drive IC power to shut down the Gate.*
- *IGBT Drive Buffer IC Shutdown: In a Safety situation, turn the pin of the Gate Drive or Drive buffer IC high through the Safety B (SB) circuit to shut down the Gate.*

Status	SC-SA	SC-SB	Digital Output (Trip)
Short	Normal	Normal	Off (Low)
Open	Safety trip (Shut down)	Safety trip (Shut down)	On (High)

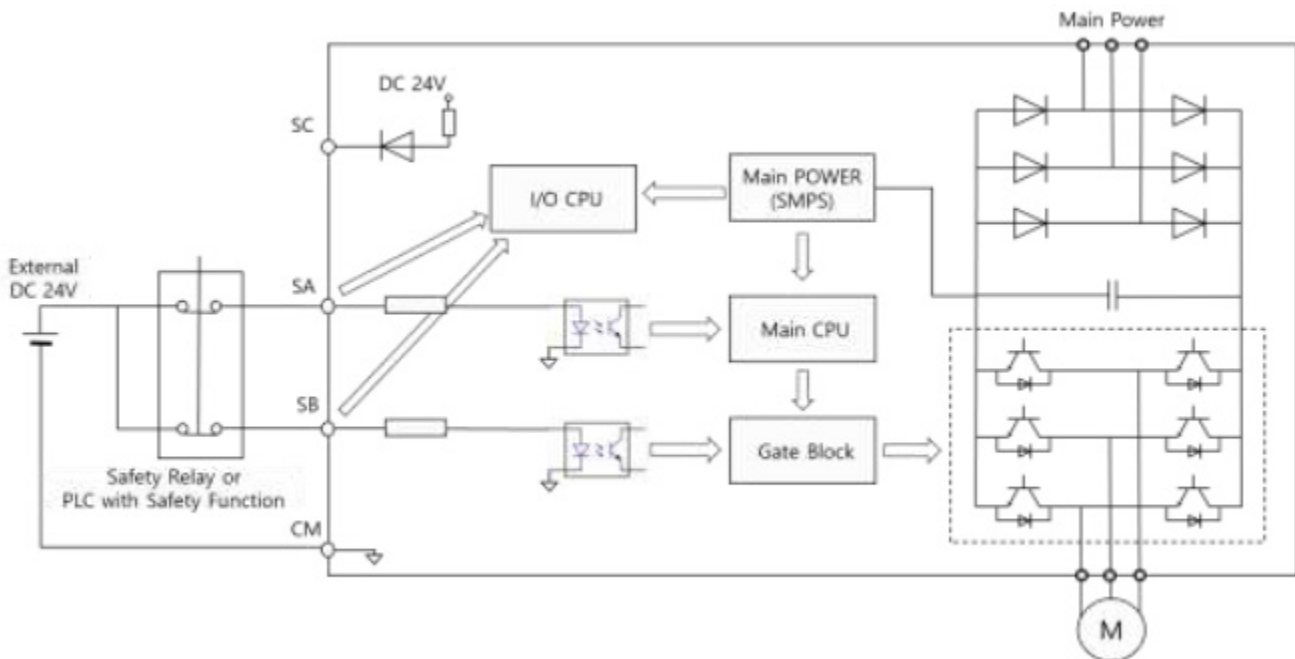
WIRING DIAGRAMS

INTERNAL STO CIRCUIT

In the figure below, the factory setting for SC-SA and SC-SB is short circuit by a factory installed jumper.



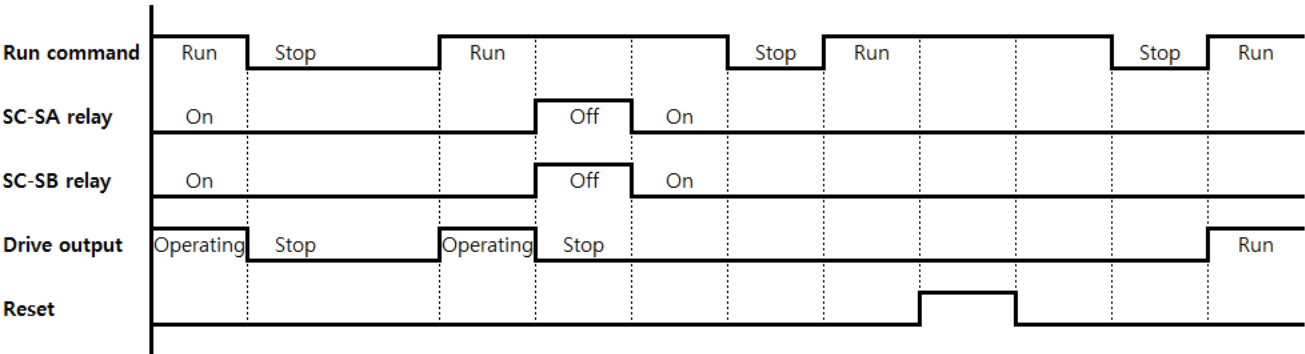
STO CIRCUIT WHEN USING EXTERNAL 24VDC POWER



OPERATING SEQUENCE DESCRIPTION

NORMAL OPERATION STATUS

When the SC-SA and SC-SB = On (Short), the drive will execute “Operating” or “Stop” according to Run/Stop command.



SAFE FUNCTION FAILURE RATE

Item	Definition	Performance
SFF	Safety Fraction	77%
Maximum Allowable SIL	Maximum Allowable Safety Integrity Level	SIL2
PFH	Average Frequency of Dangerous Failure	1.2×10^{-7} hour
SIL	Safety Integrity Level	SIL2

SAFETY REQUIREMENTS SPECIFICATION

INSTALLATION CONSIDERATIONS

The extremes of all environmental conditions (including electromagnetic) that are likely to be encountered by the PDS (SR) during storage, transport, testing, installation, commissioning, operation and maintenance.

Item	Description
Ambient Temperature	Heavy Duty: 14~104°F(-10~40°C)
Ambient Humidity	90% relative humidity (no condensation)
Storage Temperature	-4~149°F(-20~65°C)
Environmental Factors	An environment free from corrosive or flammable gases, oil residue or dust
Altitude/Vibration	Lower than 3,280ft (1,000m) above sea level/less than 1G (9.8m/sec ²)
Air Pressure	70~106kPa

SAFE FUNCTION PERFORMANCE

For each safety-related function (or group of simultaneously used safety functions), both a SIL capability and a maximum probability of dangerous random hardware failure.

Item	Definition	Performance
SIL	Safety Integrity Level	2
PFH	Average Frequency of Dangerous Failure	$\geq 10^{-7}$ to $< 10^{-6}$
Category	Category	Category 0
PL	Performance Level	d

Note. The PFH is sometimes referred to as the frequency of dangerous failures, or dangerous failure rate, in units of dangerous failures per hour.

The standard of Safety Integrity Level and Performance Level is as follows:

PL (ISO 13849-1)	PFH	SIL (IEC 61508, 62061)
a	$\geq 10^{-5}$ to $< 10^{-4}$	-
b	$\geq 3 \times 10^{-6}$ to $< 10^{-5}$	1
d	$\geq 10^{-6}$ to $< 3 \times 10^{-6}$	1
d	$\geq 10^{-7}$ to $< 10^{-6}$	2
e	$\geq 10^{-8}$ to $< 10^{-7}$	3